

PTYCHOSTOMUM PACIFICUM (BRYACEAE), A NEW FEN SPECIES FROM CALIFORNIA, OREGON, AND WESTERN NEVADA, USA

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ABSTRACT

Ptychostomum pacificum J. R. Spence & Shevock, a new and highly distinctive species restricted to fen habitats within coniferous forests in California, Oregon, and extreme western Nevada is described and illustrated. This species appears to be related to *P. turbinatum* (Hedw.) J. R. Spence but is easily distinguished by a combination of features including large size, percurrent yellowish-brown costa with numerous incrassate cells at the leaf tip, strongly recurved leaf margins, and elongate cylindrical to narrowly pyriform capsules.

Key Words: *Bryum*, cascades, mosses, Sierra Nevada.

The genus *Bryum sensu lato* with nearly 450 currently recognized species (Crosby et al. 2000) remains a complex and taxonomically challenging group of mosses. However, this polyphyletic genus has recently been divided into several segregate genera (Spence 2005, 2007; Spence and Ramsay 2005; Holyoak and Pedersen 2007). The Bryaceae are a major component of the bryoflora along the Pacific slope of North America, and California, with 60 taxa, leads all other states and provinces of North America in the number of species in this family (Norris and Shevock 2004; Malcolm et al. 2009; Spence unpublished data). Historically, bryologists generally avoid collecting *Bryum* if sporophytes are lacking since most keys have relied heavily on sporophytic characters. This collecting approach has greatly hindered work on this group of mosses since many useful gametophytic characters are currently recognized to make identification of sterile collections possible. During the course of developing the treatment of the Bryaceae for the Flora of North America Project (FNA Vol. 28 in prep.), the first author determined that several additional taxa remain undescribed, and many of these new taxa reside in California. This paper is an effort to reduce this backlog of species awaiting formal publication.

This new species is described in the genus *Ptychostomum* Hornsch., which has been shown to be distinct from *Bryum sensu stricto* (*B. argenteum* Hedw. and its allies) by both molecular and morphological studies (Pedersen et al. 2003; Spence 2005; Holyoak and Pedersen 2007). Most of our familiar boreal-temperate species of *Bryum* actually belong in *Ptychostomum*, and have been transferred elsewhere for the

Bryophyte Flora of North America (Spence 2005, 2007).

Based on the herbarium record examined to date (CAS, UC), “*P. pacificum*” was first collected by the second author in 1975. This collection was sent to Dan Norris (UC) who at the time at Humboldt State University was working toward a California moss flora. The specimen was returned as “*Bryum* sp. possibly undescribed.” Many collections of this fen species were subsequently obtained by the second author but sporophytes remained unknown. In 1999, a population of “*P. pacificum*” was discovered by David Toren (CAS) in Lake County, California that contained a few sporophytes, and a couple years later the second author found sporophytes in a Sierra Nevada occurrence. Of the nearly 75 occurrences documented by herbarium vouchers, sporophytes have only been documented seven times. Interestingly, Andrews (1935) describes “sterile forms” of *Ptychostomum turbinatum* (Hedw.) J. R. Spence from the west (without specific localities) with stem lengths reaching 10 cm or more, which suggests that at least some prior collections of “*P. pacificum*” may exist in other herbaria and are likely to be labeled as *P. turbinatum*, a much smaller species.

TAXONOMIC TREATMENT

Ptychostomum pacificum J. R. Spence & Shevock, sp. nov. (Figs. 1, 2). —TYPE: USA, California, Fresno Co., Sierra National Forest, Highway 168 above Huntington Lake, 37°12'59.7"N, 119°11'30.4"W, 7375 ft., 2 Sep 2002, Shevock & Ertter 22887 (holotype: CAS; isotypes H, KRAM, MO, NY).

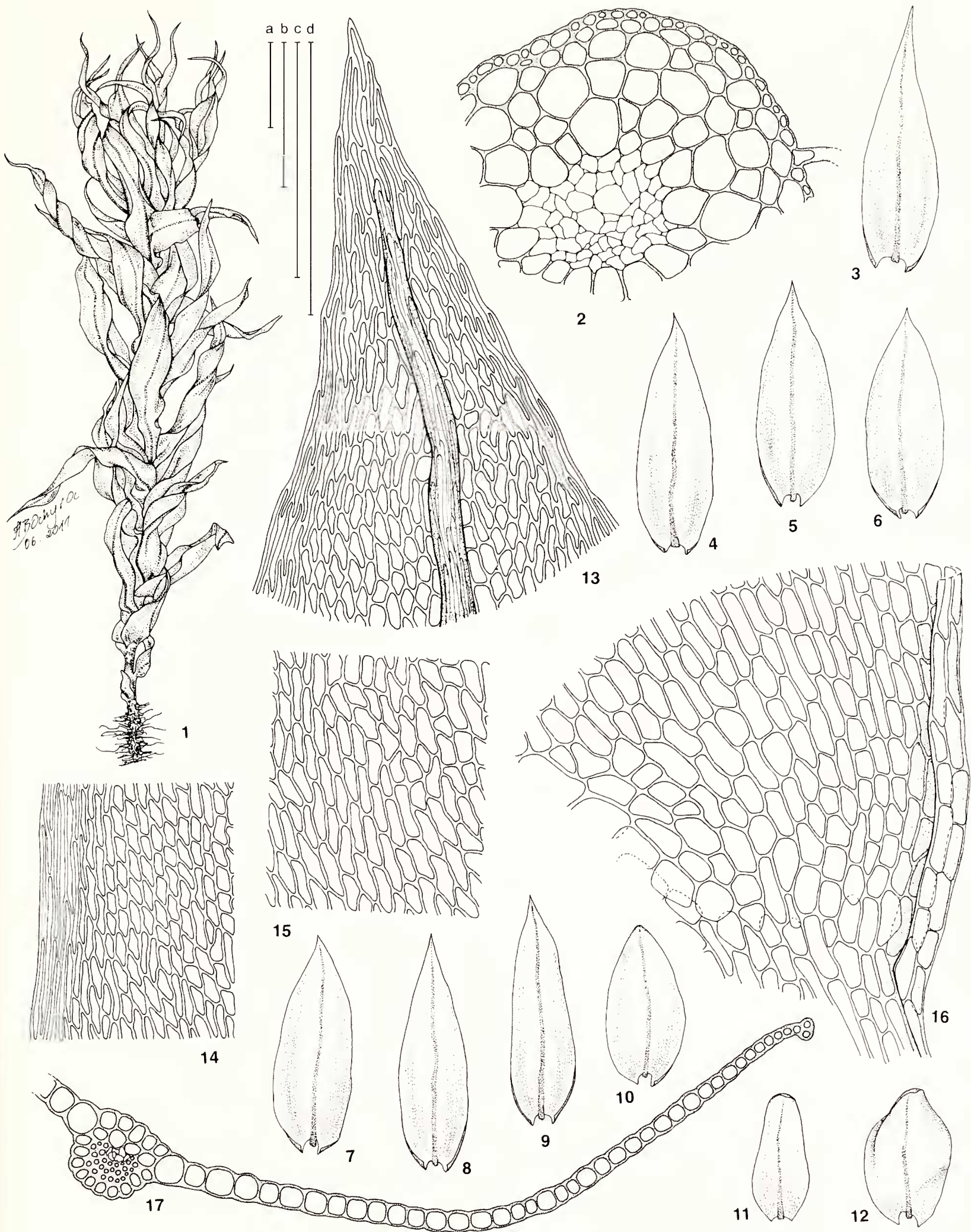


FIG. 1. *Ptychostomum pacificum* J. R. Spence & Shevock. 1. Sterile plant, dry. 2. Portion of stem transverse section. 3-9. Vegetative leaves from upper and median portion of stem. 10-12. Lower stem leaves. 13. Leaf apex. 14. Mid-leaf cells at margin. 15. Mid-leaf cells. 16. Basal cells. 17. Leaf transverse section. (All from *Toren 9586B*, KRAM). Scale bars: a - 100 µm (13-17); b - 100 µm (2); c - 0.5 cm (1); d - 0.5 cm (3-12).

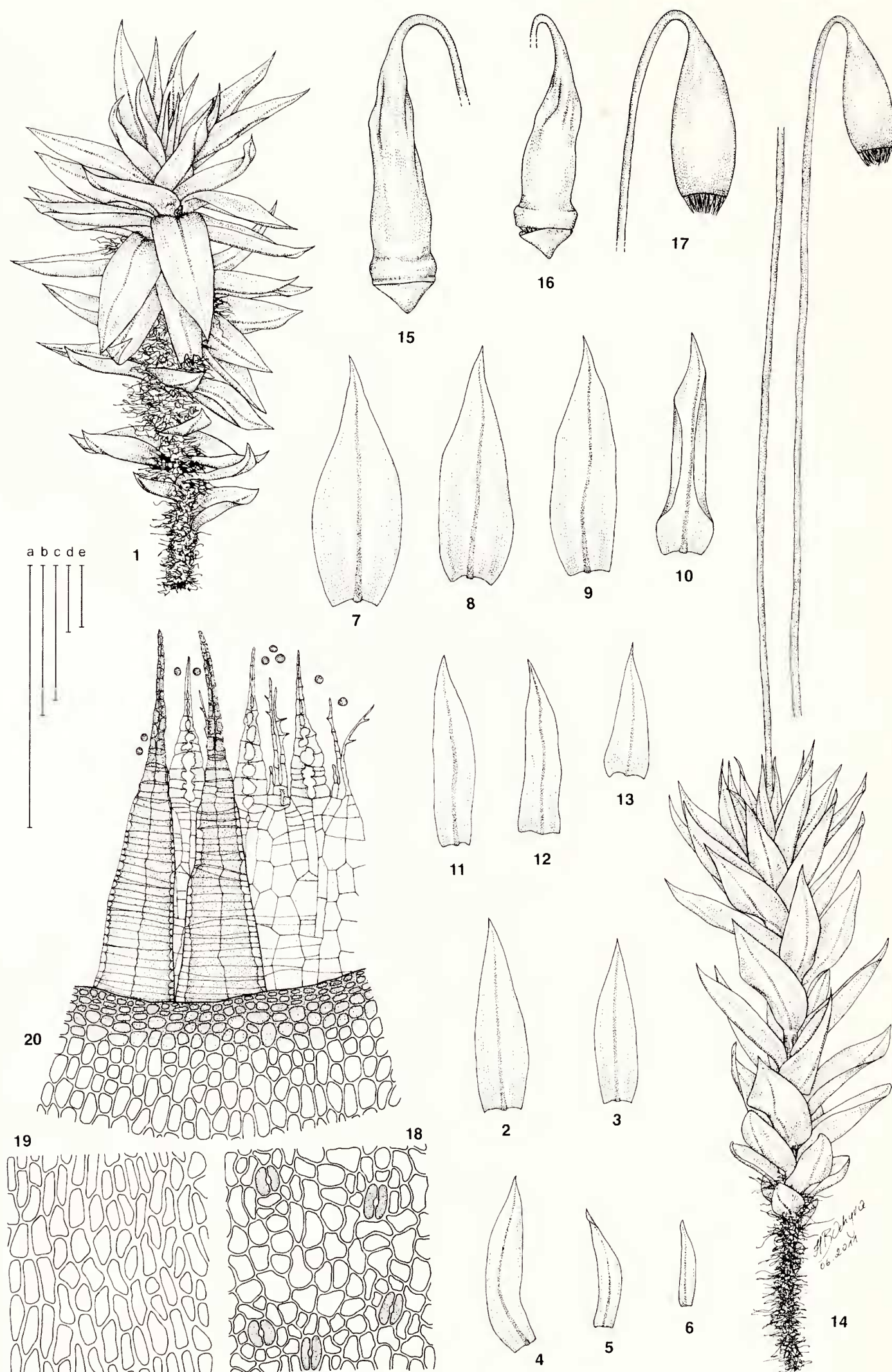


FIG. 2. *Ptychostomum pacificum* J. R. Spence & Shevock. 1. Male plant. 2-6. Perigonial bracts, sequentially from outermost to innermost. 7-13. Perichaetial leaves, sequentially from outermost to innermost. 14. Female plant with mature capsule, wet. 15-16. Operculate capsules, dry. 17. Deoperculate capsule, wet. 18. Exothecial cells at base of urn and stomata. 19. Mid-urn exothecial cells. 20. Exothecial cells at orifice, portion of peristome and spores. (1-6 from Shevock 14233; 7-20 from Toren 9586B; both in KRAM). Scale bars: a - 0.5 cm (2-13); b - 0.5 cm (14); c - 0.5 cm (1); d - 1 mm (15-17); e - 100 μm (18-20).

Plantae robustae, caulibus usque 12 cm; margines folii proximales recurvae, limbidio pervaldo, ex 2–4 stratis composito, partim bistratoso, ad apicem folii cellulis distalibus laminalibus incrassatis, saepe rubro-brunneis, costa apicem folii non attingenti vel percurrenti; capsula elongata, cylindrica vel clavata, 3–5 mm, brunnea, symmetrica.

Plants medium to robust, in dense or open turfs, green or yellow-green. Stems 2–12 cm, red-brown, lacking central strand, evenly foliate to somewhat crowded distally, often strongly radiculose. Leaves narrowly to broadly ovate-lanceolate to ovate, 3–5 mm, somewhat enlarged towards stem apex, weakly concave distally, leaves below becoming strongly concave and sometimes cucullate, weakly to moderately keeled, yellow-green to bright green, becoming blackish to red-brown when old, strongly contorted when dry, distally spirally twisted, erect-spreading to spreading wet, not or weakly decurrent; apex acute to acuminate, often colored golden-brown, margins revolute to mid-leaf, smooth to weakly serrulate distally, costa brown to red-brown, strong, not reaching apex to percurrent, rarely very short excurrent in stout serrulate awn, limbidium extremely strong, 2–4 rows, yellowish, partially bistratose below, distal and median laminal cells rhomboidal to hexagonal, 15–25 µm wide, 30–70 µm long, mostly 2–3:1, thin walled except colored distal cells which are strongly incrassate, proximal laminal cells gradually rectangular, about the same width or somewhat narrower than cells above, somewhat longer than cells above, 15–20 (25) µm wide, 40–90 µm long, often reddish, alar cells not differentiated. Specialized asexual reproduction absent. Sexuality dioecious; outer perichaetial leaves similar to vegetative leaves, inner leaves smaller, more triangular, with more acuminate apex; perigonium distinctly enlarged and conspicuous, outer leaves similar to vegetative leaves, inner leaves broadly ovate and abruptly acute. Seta 2–4 cm, straight, red-brown to yellow-brown, slender. Capsule elongate cylindric to clavate, 3–5 mm, brown, symmetric, mouth brown to red-brown, somewhat constricted when mature below mouth, exothecial cells irregularly elongate, 15–25 µm wide, 30–60 µm long, mostly 4:1, shorter in 2–3 rows at mouth; peristome well developed, exostome teeth yellow, lanceolate, 500–650 µm long, strongly trabeculate; endostome membrane high, ½ height of exostome, pale hyaline to yellowish, processes well developed, perforations oval, smooth, cilia somewhat variable, 2–3, sometimes short, mostly appendiculate; operculum low convex, apiculate. Spores pale yellow or pale brown, finely papillose, 12–16 µm.

Paratypes: USA. CALIFORNIA. **Alpine Co.:** Stanislaus National Forest, McCormick Creek drainage, S base of The Dardanelles, 7830 ft, 6 Aug 2007, *Willits 500* (CAS). **El Dorado Co.:**

1.5 mi N of Grass Valley near Tahoe Rim Trail, *Nichols 221* (USFS-LTBMU). **Fresno Co.:** Kings Canyon National Park, Pacific Crest Trail, Middle Fork Kings River, Le Conte Canyon between Ranger Station and Grouse Meadow, 8400 ft, 8 Sep 1999, *Shevock & Haultain 18634* (CAS, NY); Sierra National Forest, Kaiser Wilderness, tributary of Rancheria Creek, 9240 ft, 16 Jul 2001, *Shevock 20994* (CAS, H, KRAM); E of Idaho Lake, 8875 ft, 16 Jul 2001, *Shevock 21004* (CAS, UBC); forest road 10S66 above Bear Creek Rd., 8300 ft, 27 Jul 1996, *Shevock & Bourell 13994* (CAS, KRAM); West Snow Corral Meadow, 7100 ft., 27 Jul 1996, *Shevock & Bourell 14022* (CAS, DUKE, F, NY); between House and Ahart Meadows, 7200 ft, 28 Jul 1996, *Shevock & Bourell 14040* (CAS, KRAM, UC); John Muir Wilderness, Wet Meadows, between Rancheria and Crown Valley, 8550 ft, 16 Aug 1996, *Shevock & York 14117* (CAS, DUKE, MO, NY, OSC) & *14118* (CAS, H, KRAM, UBC, US); near Spanish Lake, 8600 ft, 17 Aug 1996, *Shevock 14165* (CAS, COLO, H, UC); Hoffman Meadow, 6800 ft, 30 Jul 2000, *Shevock & Norris 19856* (CAS, US). **Humboldt Co.:** Shasta-Trinity National Forest, Headwaters of Kerlin Creek about 5.4 air mi WSW of Hyampom, 5460 ft, 23 Jul 2009, *Lenz 4226* (CAS). **Glenn Co.:** Mendocino National Forest, Telephone Camp W of Plaskett Meadows, 6900 ft, 18 Jul 1998, *Toren 7224* (CAS, MO, NY). **Lake Co.:** Mendocino National Forest, Mt. Sanhedrin, headwaters of Mill Creek, 5450 ft, 17 Oct 1999, *Toren, Dearing & Heise 7633* (CAS); Cirque of N slope of Hull Mountain, 6300 ft, 6 Sep 1999, *Toren 7620* (CAS, NY); Snow Mountain Wilderness, Milk Ranch Meadow, 6300 ft, 25 Jun 2002, *Toren 9151* (CAS) and East Peak, 6400 ft, 26 Jun 2002, *Toren 9167* (CAS). **Lassen Co.:** N slope of Dyer Mtn., 3.4 air mi SSW of Westwood, 5900 ft, 22 Jun 2005, *Lenz 1835 & 1837* (CAS). **Madera Co.:** Devils Postpile National Monument, meadow N of Rainbow Falls, 7450 ft, 25 Sep 2001, *Shevock & Dulen 21310* (CAS); Sierra National Forest, 1.2 mi NW of Beasore Road at Cold Saddle, 7250 ft, 24 Sep 2001, *Shevock 21231* (CAS, H, KRAM); near Chipmunk Meadow, 6850 ft, 11 Jul 2003, *Shevock 24166* (BOL, CAS, KRAM, NY); W of Grey Mountain, 6800 ft, 19 Jun 2002, *Laeger 1466* (CAS); NE of Fresno Dome, 7450 ft, 6 Jul 2000, *Shevock & Kellman 19622* (CAS, DUKE); Central Camp Rd near Gags Camp, 5875 ft, 11 Jul 2003, *Shevock 24156* (CAS, DUKE, F); Poison Meadow, 6850 ft, 18 Jun 2002, *Shevock, Norris, & Clines 22420* (CAS, UC); China Meadow off of FS road 8S70, 6000 ft, *Shevock & Norris 20241* (CAS); Yosemite National Park, between Grouse and Crescent Lake, 8300 ft, 29 Jul 2009, *Shevock & Smith 33206* (CAS, MO, NY, UC). **Mariposa Co.:** Yosemite National

Park, Turner Meadow, 7365 ft, 28 Jul 2009, *Shevock, Taylor, Smith, & Colwell 33181* (CAS, MO, UC); McGurk Meadow, 6900 ft, 24 Sep 2001, *Shevock 21232* (CAS, YM); Mono Meadows, 6940 ft, 24 Sep 2001, *Shevock 21239* (CAS, MO, YM) and 11 Jul 2009, *Shevock & Hutten 33174* (CAS). **Modoc Co.:** Modoc National Forest, Headwaters of Lassen Creek, 5.8 air mi SE of Sugar Hill, 6550 ft, 23 Oct 2007, *Lenz 4097* (CAS). **Nevada Co.:** Tahoe National Forest, Pat Yore Flat, 6165 ft, 22 Jul 2010, *Wishner 10291* (CAS, UC). **Placer Co.:** Tahoe National Forest, Duncan Fen, 6710 ft, 17 Oct 2008, *Wishner 9721* (CAS, UC); Gates Fen, 5435 ft, 17 Oct 2008, *Wishner 9731* (CAS, UC); Tadpole Creek Fen, 6260 ft, 17 Oct 2008, *Wishner 9711* (CAS, UC). **Plumas Co.:** Plumas National Forest, Daly Cow Camp Fen, head of Big Pine Ravine, 1 km NNE of Camel Peak, 1591 m, 8 Nov 2006, *Toren & Janeway 9505* (CAS, MO, UC) and *Janeway & Toren 8952* (CHSC); Vaca Fen near head of S Branch Middle Fork Feather River, 1743 m, 8 Nov 2006, *Toren & Janeway 9507* (CAS, NY, UBC, UC) and 10 Jun 2009 *Dillingham & Toren 2572* (CAS); above Black Rock Campground W of Little Grass Valley Reservoir, 5150 ft, 15 Jun 2007, *Toren 9586B* (CAS, KRAM, UC); S Branch of Ward Creek, 6670 ft, 7 July 2005, *Dillingham & Toren 2057* (CAS, UC); Bucks Summit, 5360 ft, 14 Nov 2003, *Dillingham et al. 1123* (CAS); 3 mi W of Bucks Lake, 5255 ft, 13 Nov 2003, *Dillingham 1048* (CAS, UC); China Gulch Fen, 5410 ft, 10 Oct 2003, *Dillingham & Toren 1036* (CAS, UC); SE of Red Mountain, 5200 ft, 13 Nov 2003, *Dillingham & Toren 1187* (CAS); E of Tamarack Flat, 5400 ft, 13 Sep 2001, *Dillingham & Norris 404* (CAS); 7.5 mi NE of Quincy, 6285 ft, 23 Aug 2004, *Dillingham 1654* (CAS, UC); tributary to Rabbit Creek, 5300 ft., 16 Jun 2005, *Dillingham 2042* (CAS). **San Bernardino Co.:** San Bernardino National Forest, Champion Lodgepole Meadow about 0.5 mi. from Siberia Creek trailhead, 7475 ft., 26 Sep 2011, *Eliason & Williams SE09F&G* (CAS). **Shasta Co.:** Shasta-Trinity National Forest, Clark Creek ca. 2 mi E of Red Mountain, *Norris, Lenz, & Hillyard 108204* (CAS, UC); Lassen Volcanic National Park, Dersch Meadows, 6590 ft, 22 Aug 2008, *Shevock & Showers 31901* (CAS, NY). **Sierra Co.:** Tahoe National Forest: Sierra Buttes Fen, 7250 ft, 17 Aug 2009, *Wishner 12013* (CAS, UC). **Tehama Co.:** Lassen Volcanic National Park, N base of Mt. Conard, 7175 ft, 22 Aug 2008, *Shevock & Showers 31925* (CAS, MO, NY, UC, US). **Trinity Co.:** Shasta-Trinity National Forest, Headwaters of West Branch Crow Creek, 0.5 air mi SSW of Mumbo Lake, 6260 ft, 21 Jul 2009, *Lenz 4201* (CAS). **Tulare Co.:** Sequoia National Forest, Headwaters of Freeman Creek, 7000 ft, 19 Jul 1975, *Shevock 4599* (CAS) and *10638* (CAS); Freeman Creek Trail,

7000 ft, 24 Aug 1996, *Shevock 14233* (CAS, KRAM, UC); Quaking Aspen Campground, 7000 ft, 15 Jun 2001, *Shevock 20954* (CAS); Cold Spring below Portuguese Pass, 7200 ft, 2 Sep 1996, *Shevock 14314* (CAS, KRAM); Clicks Creek, 7900 ft, 24 Aug 1996, *Shevock 14252* (CAS, MO, NY); Golden Trout Wilderness, Jacobsen Meadow, 8400 ft, 23 Oct 2000, *Laeger 394* (CAS), between Redwood Crossing and Long Meadow, 6800 ft, 27 Jul 1983, *Shevock 10604* (CAS, UC), and 9 Nov 1997, *Shevock 16713* (CAS, MO, NY, UC); Sirretta Meadows, Ernest C. Twisselmann Botanical Area, 8800 ft, 16 Aug 1998, *Shevock 17522* (CAS) and stringer of Sirretta Meadows, 9000 ft, 26 Aug 2006, *Laeger & Cone 3586* (CAS); Machine Creek E of Round Meadow, 9060 ft, 29 Sep 2001, *Shevock, et al. 21380* (CAS, MO, NY, UBC, US); Round Meadow, 9000 ft, 2 Sep 1996, *Shevock 14320* (CAS, UC); Mosquito Meadow, 8800 ft, 10 Jul 1999, *Shevock 18416* (CAS, CONC, MO); Woodcock Meadow near Buena Vista, 7300 ft, 25 Oct 1997, *Shevock 16659* (CAS, H, MO, NY); Weston Meadow, 6800 ft, 28 Jun 1996, *Shevock & York 13650* (CAS, KRAM); Jennie Lakes Wilderness, between Marvin Pass and Mitchell Peak, 9300 ft, 11 Oct 1996, *Shevock 14553* (CAS, MO, NY) and Rowell Meadows, 8850 ft, 2 Aug 2002, *Laeger & Hayden 1611* (CAS); Sequoia National Park, Quinn Snow Survey Cabin NW of Soda Butte, 8200 ft, 24 Oct 2000, *Laeger 430* (CAS); Log Meadow, Giant Forest, 6800 ft, 25 Oct 1997, *Shevock 16679* (CAS); NE of Bald Dome, 8595 ft, 23 Jul 2008, *Jones 315D* (COLO, KRAM). **Tuolumne Co.:** Stanislaus National Forest, Sapps Meadow, 6725 ft, 4 Jun 2009, *Willits 501* (CAS); Yosemite National Park, ridge SE of Kibbie Lake, 7365 ft, 12 Sep 2008, *Colwell et al. 08-596a* (CAS, YM); E of Knapp, *Colwell et al. 09-494* (CAS, YM). **NEVADA. Washoe Co.:** Sierra Nevada, Humboldt-Toiyabe National Forest, Tahoe Meadows, 8740 ft, 13 Sep 2009, *Wishner 9512* (CAS, UC). **OREGON. Douglas Co.:** wetland in basin below jct. of forest road 250 and 251, 5475 ft, 6 Aug 2007, *Wagner m2308* (CAS). **Lane Co.:** Willamette National Forest, E side of Little Groundhog Mountain at jct. with forest road 452, 6.5 mi ESE of south end of Hills Creek Reservoir, 5240 ft, 23 Jul 2004, *Wagner m1390* (CAS, UC); Three Sisters Wilderness, Quaking Aspen Swamp, 8 mi E of McKenzie Bridge, 4465 ft, 8 Aug 1999 & 1 Oct 2009, *Wagner m0730a, m2556a & m2556b* (CAS).

Etymology: the species is named for its distribution along the Pacific Coast of the United States in California, Nevada, and Oregon.

TAXONOMIC RELATIONSHIPS

Ptychostomum pacificum has previously gone un-noticed due to its morphological similarity to

several related species in western North America. The new species appears to be closest to *P. schleicheri* (Schwägr.) J. R. Spence and *P. turbinatum* (Hedw.) J. R. Spence, but also mimics large specimens of *P. pseudotriquetrum* (Hedw.) J. R. Spence & Ramsay. All these species occur on wet sites on soil, organic muck, and sometimes wet rocks, and all can occur in various kinds of wetlands. Until sporophytes were discovered it was generally thought to be a robust form of *P. turbinatum*. However, that species has broadly turbinate capsules, a plane leaf margin (occasionally revolute proximally), usually short-excurrent costa, and is a much smaller plant with smaller leaves (to 4 mm) and shorter stems (to 3–4 cm). *Ptychostomum schleicheri* is also robust, but is characterized by its broad, uncontorted, yellowish leaves, very broad laminal cells, and turbinate capsules. *Ptychostomum pseudotriquetrum* differs from *P. pacificum* by its strongly decurrent leaves, distinctly short-excurrent costa, shorter proximal lamina cells, and unistratose limbidium.

The most distinctive features of *P. pacificum* include the large size, colored leaf tip with incrassate cells, mostly percurrent or shorter costa, proximally recurved leaf margins, very strong limbidium, large conspicuous perigonia, and elongate capsule.

HABITAT AND ECOLOGY

Ptychostomum pacificum is restricted to perennially wet fen habitats within coniferous forests primarily dominated by *Pinus contorta* Lounon, *Abies concolor* (Gordon & Glend.) Lind., *Abies magnifica* A. Murray, or a combination of these species. Few flowering plants occur among populations of *Ptychostomum pacificum*. Taxa listed on herbarium labels for multiple occurrences of *P. pacificum* include *Camassia quamash* (Pursh) Greene, *Dodecatheon jeffreyi* Van Houtte, *Drosera rotundifolia* L., *Eriophorum crinigerum* (A. Gray) Beetle, *Kalmia polifolia* Wangenh., *Ledum glandulosum* Nutt., *Pedicularis groenlandica* Retz., *Phalacroseris bolanderi* A. Gray, *Rhododendron occidentale* (Torr. & A. Gray) A. Gray, *Saxifraga oregana* Howell, *Salix* spp., *Vaccinium uliginosum* L. ssp. *occidentale* (A. Gray) Hultén, and *Veratrum californicum* Durand. Bryophytes generally associated with *Ptychostomum pacificum* include *Aulacomnium palustre* (Hedw.) Schwägr., *Drepanocladus aduncus* (Hedw.) Warnst., *Philonotis americana* (Dism.) Dism., *P. tomentosa* Mol. in Lor., *Ptychostomum weigeli* (Spreng.) J. R. Spence, *Sphagnum* spp., and occasionally, *Meesia triquetra* Ångstr. Fen habitats throughout the range of *Ptychostomum pacificum* are acidic in pH and all populations contain one or more members of the Ericaceae, usually *Vaccinium*, *Kalmia*, or *Ledum*. *Ptychostomum turbinatum* is reported to be mildly calciphilous, *P. schleicheri* is reported to

be acidophilous, and *P. pseudotriquetrum* appears to be tolerant of a relatively broad range of pH conditions.

At first glance, *P. pacificum* colonies (especially male plants) are reminiscent of *Rhizomnium pseudopunctatum* (Bruch & Schimp.) T. Kop. in stature and mat growth-form, although *P. pacificum* is considerably more yellow-green in color. However, with a hand-lens inspection it is clear that this plant is actually a member of the Bryaceae and not the Mniaceae.

DISTRIBUTION

Populations of *Ptychostomum pacificum* range from the Cascades of central Oregon in the Three Sisters Wilderness, Willamette National Forest, Lane Co. southward to the southern portion of the Sierra Nevada of California on the Sequoia National Forest, Tulare Co. with a disjunct occurrence recently discovered in the San Bernardino Mountains, San Bernardino National Forest. In northern California this species also extends west and south from the Klamath Mountains into the Northern Coast Ranges, Mendocino National Forest and just east of Lake Tahoe in Nevada, Humboldt-Toiyabe National Forest. Although *P. pacificum* occurs across a wide geographical area, the actual habitat of perennially wet fens within montane to subalpine coniferous forests is considerably restricted. Populations range in the north from 4465 feet to over 9300 feet in the southern portion of its range. Based on the herbarium record, this species is more frequently encountered in the Sierra Nevada of California, especially from Yosemite National Park southward. However, this may be an artifact of the more systematic bryophyte inventory work that has occurred in this portion of the species' range.

CONSERVATION IMPLICATIONS

Fens throughout the Pacific Slope are very fragile habitats and are ecologically diverse and species-rich environments. Within the coniferous zone these fens comprise less than two percent of the landscape. Some of these fens have been adversely impacted by intensive grazing activities, or have been drained, channelized, or the water flow through them altered by road construction or erosion by headcutting. However, these riparian systems today are viewed as important habitat types for biodiversity. Nearly all reported populations of *Ptychostomum pacificum* are on public lands either administered by the USDA, Forest Service or the USDI, National Park Service. Since fen habitats are increasingly likely to receive a wide variety of protective measures by these land-management agencies, the long-term conservation of this narrowly distributed species seems secure.

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